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ABSTRACT

This paper describes a one-semester remedial biology course for freshmen college students. It includes rationale for such a course at the college level, course content and organization, and instructional strategies associated with specific problem areas such as the inability of students to categorize and distinguish between categories. Appendices include lecture and laboratory schedules, vocabulary lists, question sets, and study sheets, hour examinations, and sample "hand-outs." (JN)

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A REMEDIAL BIOLOGY COURSE FOR FRESHMEN
COLLEGE STUDENTS

by

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Paper presented at the Annual Meeting of the National Science
Teachers Association, New York, 1981

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INTRODUCTION

Because of the demographic decline in the traditional potential student population, colleges and universities are in serious financial difficulties. It seems that almost every week we read that institutions of higher education have made drastic curtailments in monies for supplies and equipment and are considering eliminating departments, discontinuing entire programs, and retrenching tenured faculty members.

In an attempt to remain viable, many institutions have lowered their admission requirements; "open door" and "open admission policies are commonplace. Students who just a few years ago might never have had an opportunity to attend college (on the basis of their Scholastic Aptitude Test (SAT) scores) are now being actively and competitively recruited. For example, California State College (California, Pennsylvania), which has an almost open admission, has been successfully recruiting among the high schools in inner-city Philadelphia.

So, we are admitting some students who are probably academically under-prepared, culturally disadvantaged, and little motivated to all programs of higher education, including the sciences.

The decline in SAT scores is a fact that must be faced. Why has the occurred? The blame has been placed on elementary and high school teachers, television, pop-culture, or any other convenient scape-goat.

...we need to stop passing the buck, each blaming others for faulty schooling. The following verses from a forgotten source make the point:

The college professor: Such rawness in a pupil is a shame.

Lack of preparation in the high school is to blame.

The high school teacher: What crudity!

The boy's a fool!

The fault of course is in the middle school.

Middle school teacher: From such stupidity may I be spared.

Thet send them to me so unprepared.

Elementary teacher: Kindergarten
blockhead! And they call
That preparation. Worse than none at
all!

Kindergarten teacher: Such lack of
training never did I see.
What kind of woman must that mother
be?

Mother: Poor helpless child! He's not
the blame.

His father's folks are just the same. (Shane, 1981)

Whatever the cause, these "new" or "non-traditional" students represent a significant percentage of our incoming freshmen. As college professors, instructors, and educators, we must address ourselves to these students, either by admitting that we would rather not be involved with them until and if they reach an upper level course in our specific disciplines or by developing programs and techniques that will enable them to cope with traditional academic standards.

It is our personal belief that these students have a right to higher education (especially at public institutions) and that they deserve our best efforts to help them succeed and remain in school. The greater community which an institution serves will be enhanced by each person we graduate into it.

Jeanette S. Mullins is a botanist with graduate degrees in plant taxonomy and plant physiology. She is currently engaged in biosystematic and floristic research as well as teaching both graduate and undergraduate level biology courses. Dr. Mullins has indicated that,

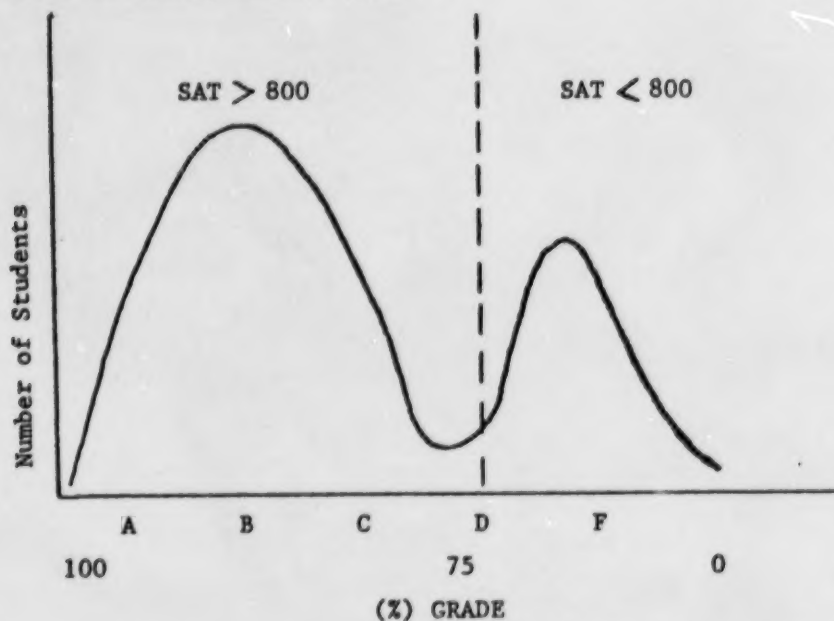
Prior to 1978, my teaching techniques were based on modeling behavior. My teaching could be characterized as direct and fact-centered. Since that time, under the direction of my collaborator, Dr. John A. Novak, Assistant Professor of Science Education at The Ohio State University, I have been learning the art and science of teaching. The information to follow represents the combined efforts of both Dr. Novak and myself.

BACKGROUND

Since her appointment to California State College in 1975, Dr. Mullins' teaching responsibilities have included the introductory course for biology department majors- the tough, no-nonsense, weed-out introductory course

in cellular biology called Principles of Biology. The outline for this course is in Appendix A-1.

With the influx of the new and non-traditional students, instructors teaching Principles of Biology found that they were obtaining the following curve on hourly examinations:



The scores of the new/non-traditional students appeared in the SAT < 800 range. This range correlates with poor reading and quantitative skills as measured by the SAT. It was strongly suspected that these students could not read, speak, or understand the language of their professors or their textbooks!

A number of instructors at California State were concerned about the students in the second curve, most of whom flunked out during their first or second semester. With the urging of the Developmental Education Committee and support of the academic dean at California State, a course in introductory remedial biology for biology majors was designed. This course was to prepare students to take Principles of Biology. It was hoped that this remedial course would permit instructors to maintain high academic standards and at the same time give the underprepared student the necessary skills and knowledge to meet these standards.

The remedial course was titled Concepts of Biology. It has a three-lecture per week format and is taught only during the fall semester.

Students who continue in Biology may claim it as a natural science elective.

Since this course was developed, entering freshmen expressing the desire to major in biology are screened on the basis of their SAT scores. An SAT score of 800 or less places a student in Concepts while an SAT score above 800 places a student in Principles. If a student with an SAT score below 800 wishes to take Principles, s/he may do so, even though strongly advised against it.

For the past two years Dr. Mullins has been the sole instructor in charge of Concepts, which enrolls approximately 40% of all entering freshmen in biology. She knows most of these students on a one-to-one basis and finds them delightful individuals, and assuredly not stupid. Some have been very successful in subsequent biology classes. One student from the 1978 Concepts of Biology class was given both the California Outstanding Biology Student Award and Outstanding Biology Senior Award.

INSTRUCTIONAL STRATEGIES

Many of the strategies described are already familiar to most teachers. However, the viewpoints represented are our own, and we take full responsibility for them.

Since Concepts is remedial (concerned with the correction of faulty study habits and the raising of a pupil's general competence- Webster's New Collegiate Dictionary), we believe the course should be developmental and not for the purpose of weeding-out. The course is structured so that students will pass!

Each student is given the opportunity to perform to the best of his/her ability. It is realized that there will be some tasks that all students can perform, and other tasks that only a few students can perform.

It is also realized that some students are not really as yet committed to biology as a major or perhaps have an unrealistic, romanticized idea about the subject matter of biology. We believe that these students should not be penalized by a poor grade, as this would tend to make all of higher education an aversive and may cause them to leave school entirely. However, those students who do plan to continue in biology should be

intellectually challenged. The classroom environment is made to be as reinforcing as possible.

The following instructional strategies are used in Concepts of Biology. The list does not represent any order of priority.

1. Easy to perform tasks are given so students may earn points. These tasks are designed so that all students are able to pass the course. This is mentioned to students several times during the semester: "This course is designed so that you can pass! I'm doing as much for you as I can. What do you have to do?" Naturally, the expected answer is given: "WORK!"

2. Students names are memorized by the instructor by the second week of class, even in classes with fifty or more students.

3. On the first day of class, and many times thereafter, students are told: "Each of you is a very special, unique person. You are important to me! I care about you." This is followed up by actions which reinforce these words.

4. Enthusiasm about the subject matter is demonstrated. Its applicability to everyday life is also demonstrated: "Now, when you go home at Thanksgiving, instead of saying 'Pass the sugar, Aunt Lizzy.', say 'Please pass the sucrose; you know of course its a disaccharide made up of glucose and fructose held together by a glycosidic bond and formed by dehydration synthesis.'"

5. Subject matter from the students' world is incorporated into lectures: Pirates, Steelers, student newspaper, current movies (Have you seen 9 to 5?), etc. These sorts of things are incorporated into lectures to hold student interest. "How many ATP's did Mr. Hart use up while he was hanging from the bedroom ceiling?"

6. A great deal of humor is used. Being a weight watcher helps, especially during the unit on lipids. The antics of Oscar, Dr. Mullins' nasty, old, 27 pound Maine coon cat is brought into lecture material when appropriate.

7. Students are never criticized, either during class or in private conferences. One-to-one sessions are arranged if a particular student needs remediation.

8. Subject matter in Concepts is constantly related to its value in

Principles

9. The students are told: "Sure, you're in Concepts- so -you've got the edge on Principles. You just need some extra help and that's what I'm here for!"
10. Detailed explanations are given as to how tasks are to be done and why they are to be done.
11. Reciprocal inhibition or desensitization (exposure to a feared situation in a non-threatening environment) is used to reduce fear of tests. This technique is explained to students, that it is being used and most important, why it is being used.
12. Attendance is usually high in Concepts. A cheerful attitude is maintained by the instructor. A grouchy, frowning, moody instructor is an aversive. Who knows, maybe on some days a student shows up just to hear about Oscar or to see if and what kind of hat Dr. Mullins is wearing.
13. Students are trusted. It is explained that trust is on-going, from the first to the last day of class, and after the class is over. Cheating has never been a problem in Concepts.
14. Students are encouraged to ask questions.
15. Students are encouraged to answer questions, even if their answer may be incorrect. Incorrect answers are used as a teaching tool to indicate some of their pre-conceived ideas about biological processes. For example: "Bill, what is respiration?" Bill: "Breathing." "WRONG!" Bill and other students are always praised for speaking up.
16. Positive comments are written on examinations and homework assignments.
17. The neat and nifty biology courses students can take after they complete Principles are described. "This is a commercial! Plant Taxonomy gets you outside- into the mountains, bogs, and mud!"
18. Students who do not wish to continue in biology are encouraged to seek an alternative major. Other possibilities are freely discussed with them.
19. Students who do wish to continue in biology but are doing poorly are given extra, private remediation.
20. Talking down to students is avoided. If words are used that students may not understand, they are spelled or written on the board

(for example, site). If the word is difficult to pronounce, oral drill is used: EN-DO-PLAS-MIC RE-TIC-U-LUM.

21. Students are given methods for improving their study habits, including outlining, devising questions, etc. Private versus group study is discussed. Compatible study groups are facilitated by the instructor.

22. Pledging and/or partying are not discouraged. Instead, life goals are discussed. Parties and frats are a part of college life. What these students need to determine for themselves is how much social life they can handle.

23. Assignments and examinations are announced well in advance and returned (after grading) promptly.

24. Special problems which cannot be handled are referred to the counseling center.

COURSE ORGANIZATION

SUBJECT MATTER:

The course outline for Concepts of Biology is included in Appendix A-2. It appears that the topics of (1) cells; (2) Molecules of Life; (3) Respiration; and (4) Photosynthesis are most difficult for students in this course. Therefore, these are the topics which are discussed in the greatest detail.

GRADING SYSTEM:

Total points (1000) may be earned in the course as follows:

1. Lecture Examinations (500 points)
Five 100 point non-cumulative examinations
2. Homework (300 points)
Five sets from student's study guide (10-40 points)
Two chapter outlines (50 and 100 points respectively)
Two question sets (25 points each)
3. Vocabulary Quizzes (200 points)
Ten 25 point quizzes (four lowest are dropped)
Two 25 point quizzes (neither can be dropped)

4. Grade Assignment:

900-1000	A
800-899	B
700-799	C
600-699	D
<600	F

ATTENDANCE:

Attendance is taken only to determine motivation and is not considered in assigning grades to students.

FORMAT:

Lecture material is presented very slowly at first with frequent repetition with a gradual acceleration in pace to that a normal lecture speed is attained by the end of the semester.

TEXTBOOK & STUDY GUIDE:

The textbook and study guide were selected for this course because the authors have incorporated modern learning theory as well as subject matter into their materials. In addition, objectives, pictures, discrete units, vocabulary lists, unit test questions, and outlines are featured. These materials are:

Understanding Biology (Applewhite, Wilson and Roe, 1978)

and

Study Guide for Understanding Biology (Applewhite and Wilson, 1978)

We will now examine some features of Concepts of Biology in greater detail.

VOCABULARY QUIZES

A 25 point vocabulary quiz is administered every Friday. A list of words that will appear on this quiz is distributed on Wednesday.

Examples of these vocabulary lists are presented in Appendix B.

Students with SAT scores lower than 800 probably have verbal difficulties. Most people are aware of the reading problems at the elementary and secondary levels- today higher education is not immune.

Students are told that they must possess the basic vocabulary of the biological sciences so that they can understand both their professors and their textbooks. It is explained that definitions, often not given as such in Principles, are expected knowledge on the part of the student.

Objectives of the Vocabulary Quizzes

To:

1. increase the students' biological vocabulary;
2. give students a model for memorization;
3. provide a vehicle for group interaction at the vocabulary review sessions;
4. provide a tool for individualized positive reinforcement;
5. provide a relatively easy task for even the most poorly prepared or motivated student;
6. aid students in constructing complete sentences;
7. aid students in discovering what the instructor considers to be an acceptable answer;
8. reciprocally inhibit students to weekly vocabulary quizzes (these are given in Principles);
9. encourage students to discover definitions for themselves, either in their readings or in their lecture notes;
10. provide an opportunity for individualized instruction for students who are having problems; and
11. provide meaningful opportunities and motivation to spell correctly.

These quizzes gradually increase in difficulty: from 5 to 8 to 10 words; from anything that resembles a correct answer being given full credit to complete sentences in which all words must be correctly spelled for full credit; from no time limit to 15 minute time limit; and from "drop" to "no drop."

At the beginning of the semester definitions are dictated verbatim. Later, students must begin to discover definitions for themselves. Vocabulary review sessions are held each Wednesday for students who want to attend. Attendance gradually increases as the semester progresses. Verbatim definitions are not given at these sessions. Instead, students are encouraged to seek their own definitions, to use operational definitions, etc. Compatible study groups are identified during these sessions and encouraged to meet together. There are three separate groups of students who attended these sessions in 1979 and are still studying together although they are taking other biology classes.

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now famous "never empty candy jar" is passed around, "full of ATP's!" When bioenergetics is covered, the candy jar image is there to help.

There are two versions of these quizzes (samples are included in Appendix B). Two versions are used due to the large number of students in the lecture room. At the beginning of the semester these alternative forms have "Oscar" and "Daisy" at the top of the page. As the course progresses, the design is changed to fit the season or to incorporate new knowledge.

Quizzes are returned at the beginning of the next lecture session. Each definition is read from papers of two different students. This technique serves to: (1) reinforce the correct definition; (2) let others in the class know it can be done; and (3) give a "goodie" to the students whose quizzes are chosen to be read. Therefore, two students are given another form of positive reinforcement each week. This is especially effective with those students who have a poor self image.

HOMEWORK

Objectives of Homework Assignments

To:

1. provide a transition-type task between high school and college courses;
2. encourage students to ask themselves about course material;
3. aid students in recognizing areas of misunderstanding;
4. reciprocally inhibit students to examination questions;
5. be used as a tool in group dynamics in which students are encouraged to ask each other questions;
6. inform students as to the types of questions that will be on examinations and what types of answers are considered to be acceptable;
7. provide study guides for examinations;
8. positively reinforce those students whose questions and answers are read to the class; and
9. provide an easy task which even the most under-prepared student can accomplish.

STUDY GUIDE HOMEWORK

This consists of answering questions at the end of the chapter. These are "cake points," that is, the answers may be found in the back of the Study Guide. This homework is due at the end of each unit.

Objectives of Study Guide Homework

To:

1. bolster low point totals, thereby lessening the students' apprehension about grades;
2. provide even the weakest student with an easy method of earning points; and
3. confront the student with a different presentation of the material covered in the lecture and textbook.

CHAPTER OUTLINES

The primary objective of these assignments is to show students how to actively rather than passively read their text assignments. Most college instructors have heard students say, "But I read the book!" after performing poorly on a test or quiz. Active and passive studying are discussed. "You've got to use up ATP's! You should feel like you have been working after you study!"

Chapter outlines are assigned for those units considered to be most difficult for students, namely, basic chemistry, respiration, and photosynthesis.

In keeping with the policy of making this course as reinforcing as possible, the full number of possible points is given to students who hand in the outlining assignments on time. Private appointments are scheduled for those students who do have difficulty in preparing an outline.

Objectives of Chapter Outlines

To:

1. provide a model for active rather than passive study;
2. provide easily obtainable points;
3. identify students with reading and comprehension problems;
4. force students to write out difficult concepts; and

5. provide a model for dealing with text reading assignments.

QUESTION SETS

Question sets are announced well in advance of the last two hour examinations. The primary purpose of using these sets is to help prepare students for these examinations- the most difficult tasks of the course.

Another function of these assignments is to reduce the students' fear of the impending examinations by desensitization or reciprocal inhibition. Exam jitters, self-doubts, and study habits are discussed before these assignments are given.

The lecture examinations become more difficult as the semester progresses, more like examinations they will have in Principles.

By this time in the semester most students are writing using complete sentences and are capable of writing a three-sentence definition. At this point students are challenged to formulate definitions from information, for example using material on page 52 of their notes and pages 62 and 95 of their text.

The task of the first question set is to have students devise 3 short answer questions and then answer them (See Appendix C). This set is returned and discussed one week before the examination. Questions and answers from selected student papers are read to the class as examples of well written questions with varying levels of difficulty. This serves to:

1. provide students with information on the subject matter to be covered on the examination;
2. provide students with a model of examination question format;
3. reduce exam jitters; and
4. reinforce those students whose assignments are read to the class.

Students whose papers are read are never identified so as not to embarrass an individual. This is a "personal goodie" from instructor to student. Papers are selected from students who have not been previously reinforced in this manner.

The second question set (100 points) is due one week before the last

lecture examination. This examination is a real Principles examination! This assignment requires each student to generate 25 multiple choice and 25 fill-in the blank questions using subject matter content from their lectures. Students are required to provide the correct answers for each question.

The assignment is scored as to how well the questions are answered. Naturally, students do quite well. The high grades are therefore reinforcing and aid in lessing exam jitters.

At this point in the semester, some students are able to devise and answer difficult questions. For example,

The light reactions of photosynthesis:

- a. occur in the solid state
- b. are non-enzymatic
- c. produce NADPH and ATP
- d. all of the above

This assignment is returned before the examination and questions considered to be too easy are discussed with specific reasons as to why they are easy, for example:

Chlorophyll is a:

- a. Mullins favorite
- b. molecule
- c. tooth decay preventer
- d. green land fill

Objectives of Second Question Set

To:

1. prepare students to take an objective examination by devising their own questions;
2. reduce exam jitters;
3. provide students with cogent examples of objective examination questions; and
4. aid in identifying those students who might be successful in Principles.

As a matter of general policy, the types of questions indicated to be on the examination are on the examination. Consistency on the part of the instructor helps to foster trust and confidence in the students. We believe that students in remediation need a well-defined course structure.

THE HOUR EXAMINATIONS

General objectives of the hour examinations are to:

1. provide the student and instructor with an evaluation of their knowledge of the subject matter;
2. provide increasingly more realistic predictors of success in Principles;
3. provide different types of examination questions to which students may be exposed in Principles;
4. help the student decide whether s/he wishes to continue in biology; and
5. help the student and instructor discover problem areas in their remediation.

Examples of hour examinations are given in Appendix D.

Examinations 1 and 3:

All questions and answers to these examinations are known by the students well in advance of the examinations. All questions for Examination 1 come directly from the Study Guide unit on Chapter 1 of their text. Examination 3 covers all material from the "hand-out" on functional groups and bonds (included in Appendix D).

The primary objective of these examinations is to provide students with a good grade! In addition, Examination 3 serves as an aid in memorizing functional groups and bonds considered to be important in Principles. Students are permitted to take Examination 3 (or variations) until they achieve 100%!

Examination 2:

This examination is considered as a pretest, being very similar to examinations given in Principles. Following the technique used by Principles instructors, very little advance information on question type or depth of knowledge expected is given. The grade on this examination serves as one predictor of success in Principles. In 1980, the range on this examination was from 52 to 100, with a mean of 80. As in Principles, grades are not curved on this examination.

Examinations 4 and 5:

These are the most difficult examinations, Examination 4 similar to a Principles examination and Examination 5 an actual one given in

Principles. Both examinations are given only after a great deal of student preparation, including homework sets, study guide homework, vocabulary quizzes, and chapter outlines. Examination review sessions are also held during which students are encouraged to ask each other questions from their homework sets. Grades from Examination 5, unlike Principles are curved, the mean in 1980 being 40.

Examinations are returned at the next lecture session. We believe that not returning examinations for an extended period only builds anxiety in these students. Each question on an examination is reviewed with explanations given as to why the question was asked and why a given answer was correct and others not correct. Papers are reevaluated after this review in case of instructor error in grading.

Reviewing examinations in this fashion requires a great deal of class time with a necessary reduction in the amount of subject matter that can be covered. However, we believe that it is one function of a remedial course to instruct students on how to take an examination, what is expected of them, and why! We should not give lip service to examinations being a part of the learning experience.

PROBLEM AREAS

Some problem areas identified in 1979 with some possible solutions in 1980 are now presented. Other solutions may be equally successful, but those presented here have worked with most of our students.

Problem! Inability to categorize and distinguish between categories

Using the two reactions (Electron Transfer Reaction and Electron Sharing Reaction), students can define each reaction but cannot compare them or tell what type of chemical bond results from either even though they can define each bond (ionic and covalent) and each reaction separately.

Solution! An advance organizer in the form on a chart placed on the board before the unit on reactions and bonds.

Reaction	Bond Formed	Example
Electron Transfer	Ionic	$\text{Na}^+ \text{Cl}^-$
Electron Sharing	Covalent	$\begin{array}{c} \text{H} \\ \\ \text{H} - \text{C} - \text{H} \\ \\ \text{H} \end{array}$

Problem! Inability to differentiate a category from an example of a category

For example:

Category	Examples
Carbohydrates	monosaccharide (glucose) disaccharide (sucrose) polysaccharides (starch) sugar phosphates (glucose-6-(P))
Lipids	Fatty acids Saturated Fatty Acids Unsaturated Fatty Acids Fats Waxes

The questions on the hour examination was to name four carbohydrates and give their functions. The expected answer was:

glucose- respiratory energy
cellulose- plant cell walls
glycogen- animal carbohydrate storage
starch- plant carbohydrate storage

The most common incorrect response to this question was:

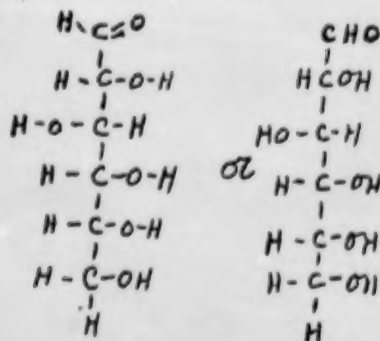
Lipids
Proteins
Nucleic Acids
Sugars

Solution! Another advance organizer. A list with major categories and examples is placed on the board before the unit is begun. This is used during each class session. Students are also encouraged to recite categories and examples in unison!

Problem! Inability to recognize and memorize structural formulae

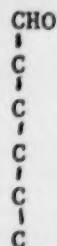
These are skills required in Principles. Examples of formulae are included in Appendix E .

Solution! Stepwise construction of the structural formula. Using glucose as the example

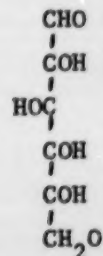
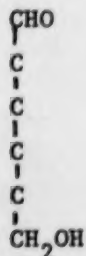


and being reminded that Carbon (C) has four bonds, Oxygen (O) has two bonds, and Hydrogen (H) has one bond, students are given specific instructions on constructing this molecule.

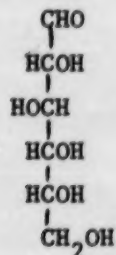
1. Draw the carbon chain.
2. Add aldehyde to C # 1.



3. Add alcohol to C # 6.
4. Add other alcohols, remembering # 3 is on the left.



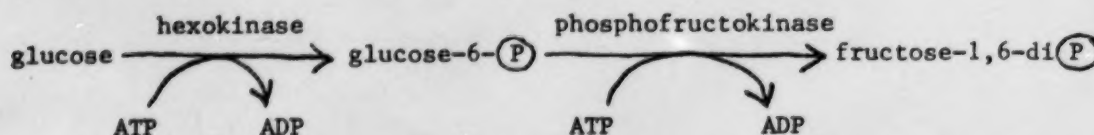
5. Finally, fill in all the blanks with Hydrogen.



Carbon chain, aldehyde, alcohol groups, and bonding are concepts that must be taught before the molecule can be constructed. Students should also know that the molecule glucose is both a monosaccharide and an aldohexose.

Problem! Inability to understand reaction sequences in a metabolic pathway or coupled reaction.

The following reaction is illustrative of the kind with which students appear to have much difficulty in understanding.



Solution! Write out each reaction individually. For example.



An explanation is then given of why writing a pathway saves time and that products of one reaction become the reactants of the next and so on.

Problem! Inability to recognize or memorize functional groups and bonds

Oftentimes this results from students not really studying.

Solution! Reward correct memorization and identification with 100 points on the third hour examination. This is stressed since students must possess this skill in Principles. Students are told that in some cases strict memorization are required and it does take effort to "get the job done." The reward is seeing points added to their total scores.

Problem! Inability to distinguish between words which are spelled similarly but have different meanings

Examples:	nucleus	glucose
	nucleolus	glycogen
	nucleoid	glycerol
		glyceric acid
		glyceraldehyde

Solution! Make students aware that these similar-looking words have different definitions (meanings). These words are written on the board with oral recitation as to different meanings.

Problem! Inability to recognize and/or memorize related subjects

Examples:	<u>Aldol Sugars</u>	<u>Cellular Organelles</u>
	aldotriose	mitochondria
	aldotetrose	ribosomes
	aldopentose	vacuoles
	aldohexose	fibrils
		nucleus, etc.

Solution! Have students devise personal mnemonics.

Problem! The concept that an electron is a particle with energy

Solution! Group oral recitation in chant form is used: "An electron is energy!" "Does it have mass?" Chanting continues.

Students are then asked to relate energy and electrons to oxidation and reduction: loss of electron = loss of energy

gain of electron = gain of energy

Two mnemonics are also helpful:

Leo the German (loss of electrons = oxidation
gain of electrons = reduction)

LEo the GERman (loss of energy = oxidation
gain of energy = reduction)

Problem! Inability to speedily and accurately copy structural formulae and pathways from the blackboard

Solution! Because students in remediation courses are oftentimes extremely poor notetakers handouts (examples in Appendix E) are used extensively. Although students are given skills in note-taking, formulae, pathways, and other complicated materials are given to students. It is suspected that students will spend more time listening to the instructor and to each other and not copying material from the board.

Problem! Advisement of Concepts students for the following semester

A rule of thumb in the biology department at California State had been that, if a student received a grade of A or B in Concepts they were advised to take Principles and either Botany I or Zoology I the following semester. This meant that A/B Concepts students would take two biology classes and general chemistry I- a total of three laboratory courses during the semester after completing Concepts.

Although students may earn a grade of A or B in Concepts, most are still not prepared to take three very traditional, laboratory-oriented college science courses. In addition, many students had little or no laboratory skills, as a laboratory was not included in the Concepts course design due to departmental and college constraints.

Solution! Adequate predictors (other than final grades) were developed to indicate possible success in Principles and/or other biology courses. The most useful predictors were found to be:

1. grade on Examination 2;
2. grade on Examination 4 (before curving);
3. attendance;
4. attendance at extra, optional sessions;
5. high number of A's on weekly quizzes; and
6. no serious verbal difficulties.

Before spring semester registration, a private conference is held with each student in Concepts. During the conference each student's achievement is reviewed relative to the six predictors. With the consent and understanding of the student, a personalized letter of recommendation is written to his/her academic advisor. For example, Jim could probably handle three laboratory courses in the spring or Jeannie and I both feel that she is not quite prepared to take two biology courses next semester.

Students who do not take three laboratory courses in the spring are aware that they may require additional semesters of college to meet all graduation requirements. They are also aware of the value of doing well in a few courses versus doing poorly in several.

Other possibilities of student talent and interest are discussed. Because of these discussions, several students in Concepts did change their majors. We believe that changing majors is not a disgrace and that it is better to switch early rather than spend time doing poorly and in all probability dropping out.

Those students who have not continued in biology were given what we consider to be a survey of cellular biology and cogent remediation applicable in other areas of endeavor. Furthermore, these students are allowed 3 college credit hours of natural science credit for successfully completing Concepts.

Our experiences described in this presentation are just one attempt to reach the academically underprepared, culturally disadvantaged, and unmotivated college student. As with any course, and remedial courses in particular, we are currently revising Bio-concepts. Individuals interested in this course may contact either of the authors.

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Appendices

- A-1 Lecture and Laboratory Schedules- Principles of Biology (Hunter et al., 1979)
- A-2 Lecture Schedule- Concepts of Biology
- B Vocabulary Lists and Sample Vocabulary Quiz Answer Sheets
- C Question Sets and Study Sheets
- D Hour Examinations
- E Sample "handouts" used in Principles of Biology

PRINCIPLES OF BIOLOGY LECTURE SCHEDULE

(Introductory Biology for Department Majors)

UNIT ONE

I. The Scientific Method

II. Cells

A. Cell Theory

B. Organization of Cells

1. Cell Structure
2. The structure of cell membrane

C. Prokaryotes & Eukaryotes

1. Prokaryotes

- a. Bacteria
- b. Mycoplasmas
- c. Cyanobacteria

2. Eukaryotes

- a. Nucleus
- b. Mitochondria
- c. Ribosomes
- d. Endoplasmic Reticulum
- e. Golgi Apparatus
- f. Microtubules & Microfilaments

3. Specialized Cytoplasmic Organelles in Plant Cells

- a. Plastids
- b. Vacuoles
- c. Cell Wall

4. The Diversity of Eukaryotic Cells

- a. Unicellular Organisms
 - 1) protozoa
 - 2) plants (algae)
- b. Cells of the Multicellular Organism
 - 1) Absorptive cells
 - 2) Secretory cells
 - 3) Nerve cells
 - 4) Muscle cells
skeletal, cardiac, smooth

5. Gametes

III. Viruses

A. Characteristics

B. Examples

UNIT TWO

I. A Chemical Background for Biology

- A. All substances composed of:
 - 1. Atoms
 - 2. ions
 - 3. molecules
 - 4. A mixture of the above
- B. Atomic Structure (briefly)
- C. The Formation of Chemical Bonds
 - 1. ionic (1-10 Kcal/mole)
 - a. metals and non-metals -----> salt
ionic
 - b. ionic bonds easily broken in water
 - 2. Covalent bonds (50 - 110 Kcal/mole)
 - a. diatomic molecules (100% covalent)
 H_2, O_2, N_2, Cl_2 , etc.
 - b. molecules of compounds
 - 1) polar covalent bonds
 - a) polar molecules (Hydrophilic)
 - b) non-polar molecules symmetrical etc. $CO_2 + CCl_4$
 - 2) Non-polar covalent bond
 - a) non-polar molecule (Hydrophobic)
 - 3. Hydrogen Bonding

II. Proteins

- A. Proteins as cellular expressions of the genetic information

DNA -----> RNA -----> protein

- B. Protein Structure
 - 1. Primary level
 - 2. Secondary level
 - 3. Tertiary level
 - 4. Quaternary level
 - 5. Denatured proteins

III. Enzymes

- A. Characteristics of enzymes
 - 1. Enzymes are proteins
 - 2. Organic catalysts
 - 3. Enzymes can be temporarily inactivated
 - 4. Enzymes lower the energy of activation
 - 5. Enzymes catalyze reversible reactions
 - 6. Enzymes have specificity
 - 7. Enzymes have optimal temperature
 - 8. Enzymes have turnover numbers
 - 9. Enzymes have active sites

UNIT THREE

I. Carbohydrates

- A. Functions
 - 1. Structure
 - 2. Storage
- B. Basic Carbohydrate Structure
 - 1. $(CH_2O)_n$
 - 2. Monosaccharides
 - a. triose
 - b. tetrose
 - c. pentose
 - d. hexose
 - 3. Isomers
 - 4. Disaccharides
 - 5. Polysaccharides

II. Lipids

- A. Neutral Fats
 - 1. function
 - 2. structure
 - 3. digestion
 - 4. fatty acids
 - a. saturated
 - b. unsaturated
- B. Phospholipids
 - 1. structure
 - 2. function
- C. Steroids
 - 1. structure
 - 2. function

III. Nucleic Acids

- A. Types of Nucleic Acid
 - 1. Deoxyribonucleic Acid (DNA)
 - 2. Ribonucleic Acid (RNA)
- B. The chemical composition of Nucleic Acids
 - 1. Nucleotides
 - a. pentose sugar
 - b. phosphoric acid
 - c. one of five nitrogenous bases
- C. Levels of Structure
 - 1. primary
 - 2. secondary
- D. DNA replication

IV. Protein Synthesis

- A. Transcription
 - 1. m-RNA
 - 2. t-RNA
 - 3. r-RNA
- B. The Code
 - 1. triplet
 - 2. non-overlapping
 - 3. comma-less
 - 4. codons
 - 5. universal nature of the code
- C. Amino Acid Activation
 - 1. t-RNA
 - 2. anti-codon
 - 3. amino acyl synthetase
- D. Translation
 - 1. initiation
 - 2. elongation
 - 3. termination

UNIT FOUR

Energy Considerations in Biology

- I. Entropy and Free Energy
 - A. Energy exchange and chemical reactions
 - B. Kinetic energy
 - C. Potential energy
 - D. Energy and Chemical Bonds
- II. Oxidation and Reduction
 - A. Oxidation
 - 1. Loss of electrons
 - a. loss of hydrogen
 - b. gain of oxygen
 - B. Reduction
 - 1. Gain of electrons
 - a. gain of hydrogen
 - b. loss of oxygen
 - C. Stepwise oxidation of hydrocarbons
- III. Respiration
 - A. Digestion
 - B. Intermediary Metabolism
 - 1. Anabolic reactions
 - 2. Catabolic reactions
 - C. Anaerobic respiration
 - 1. Three interrelated processes
 - a. phosphorylation
 - b. oxidation
 - c. energy transfer

2. Glycolysis
3. Lactic acid fermentation
4. Alcoholic fermentation
5. Pyruvic acid to acetyl CoA
6. Citric Acid Cycle
7. Oxidative phosphorylation

IV. Photosynthesis

- A. Thermodynamics
- B. History of investigations in photosynthesis
- C. Oxidation and reduction
- D. Redox potential
- E. Pigment molecule characteristics
- F. Chloroplasts
- G. Light absorption
 1. chlorophyll A
 2. the fate of excitation energy
 3. transfer of energy
- H. Light reactions of photosynthesis
- I. Formation of glucose from CO_2 in the dark reaction
- J. Summary of photosynthesis

UNIT FIVE

Genetics

- A. Genes and Alleles
- B. Law of Segregation
- C. Law of Independent Assortment
- D. Incomplete Dominance
- E. Polygenic Inheritance
- F. Multiple Alleles
- G. Linkage and Cross-Over
- H. Gene Mapping
- I. Sex-Linked Inheritance
- J. Genetics of Populations: Hardy-Weinburg

UNIT SIX

Evolution

- A. Darwin-Wallace Theory
- B. Synthetic Theory
- C. Speciation
- D. Evidence for Evolution
- E. The Origin of Life: Heterotroph Hypothesis

UNIT SEVEN

Ecology

- A. Ecosystems
- B. Biogeochemical Cycles
- C. Food Chains
- D. Habitat and Niche
- E. Dynamic Balance of Nature

PRINCIPLES OF BIOLOGY LABORATORY SCHEDULE

1. Microscopy and Microscopic Measurement
2. Prokaryotic Cells
3. Eukaryotic Cells
4. Prokaryotic Cells
5. Membrane Transport
6. Chemical Substance Found in Cells
7. Characteristics of Enzymes
8. Mitosis
9. Meiosis
10. Genetics
11. Plant and Animal Development
12. The Hardy-Weinberg Equilibrium and Evolution
13. Ecological Relationships: The Contact Slide

(Hunter, et al., 1979)

Course Outline for Concepts of Biology
(The Preparatory Course for Department Majors)

- I. Definition of Biology: The Science of Life
 - A. definition of science; the scientific method
 - B. structure/function definition of life (Paul Weisz, 1971)
 1. life functions
 - a. respiration
 - b. synthesis metabolism
 - c. nutrition
 - d. steady state controls
 - e. reproduction self-perpetuation
 - f. adaptation
 2. Life Structure; Cells
- II. Levels of the Organization of Matter
 - A. Elementary Particles
 - B. Atoms
 - C. Elements
 - D. Molecules
 - E. Compound
 - F. Complexes of Compounds
 - G. Cells
 - H. Organisms
 1. unicellular
 2. multicellular
 - a. tissues
 - b. organs
 - c. organ systems
 - I. Populations
 - J. Biotic Communities
 - K. Biomes
 - L. Biosphere
- III. Cell Structure
 - A. The Cell Theory
 - B. Eukaryotic Cell Structure
 1. plasma membrane
 2. membrane-bound organelles
 - a. nucleus
 - 1) chromosomes
 - 2) nucleoli
 - 3) membranes
 - b. mitochondria
 - c. golgi bodies
 - d. lysosomes
 - e. vacuoles (central, food, contractile)
 3. endoplasmic reticulum (smooth, rough)
 4. non-membrane bound organelles
 - a. ribosomes
 - b. microfilaments
 - c. microtubules, spindle fibers, flagella, cilia, centrioles
 5. other cytoplasmic components
 - a. macromolecules
 - b. small molecules and ions
 - c. water

6. eukaryotic plant cells
 - a. plastids
 - b. cell wall
- C. Prokaryotic Cell Structure
 1. lack of membrane-bound organelles
 2. plasma membrane
 - a. mesosomes
 - b. chromatophores
 3. gas vacuoles
 4. cell wall
 5. nucleoid

IV. Cell Function

- A. Membrane Function
 1. diffusion
 2. osmosis
 3. active transport
- B. The Molecules of Life: Structure and Function
 1. Inorganic Compounds; ionic and covalent bonds
 - a. water; hydrogen bonds
 - b. mineral solids
 - c. ions
 - d. acids, bases, pH
 2. Organic Compounds (Biopolymers); Carbon bonding
 - a. carbohydrates
 - 1) monosaccharides (monomers)
 - 2) disaccharides; dehydration synthesis, glycosidic bond
 - 3) polysaccharides
 - b. Lipids
 - 1) fatty acids (monomers)
 - 2) fats: dehydration synthesis, ester bond
 - 3) waxes
 - 4) lipid derivatives; the porphyrin ring
 - c. Proteins
 - 1) amino acids (monomers)
 - 2) peptides; dehydration synthesis, peptide bond
 - 3) polypeptide chains
 - 4) levels of structure; fibrous, globular
 - d. Nucleic Acids
 - 1) nucleotides (monomers)
 - 2) RNA
 - 3) DNA
 - 4) ATP
 - 5) nucleotide derivatives
 - a) vitamins
 - b) co-enzymes; NAD, NADP, FAD, CO-A

V. Factors Governing the Rate and Direction of Cellular Reactions

- A. Reaction Rate: enzymes
 1. structure and function
 2. denaturation
- B. Reaction Direction; the Laws of Energetics
 1. First and Second Laws
 2. Exergonic and Endergonic Reactions; ΔG
 3. Coupled Reactions; ATP
 4. Biological Oxidation - Reduction Reactions

- VI. How the Molecules of Life, Under the Direction of the Steady-State Controls, are Coordinated in a Functioning Cell.
 - A. Cellular Respiration
 - 1. glycolysis
 - 2. fermentations
 - 3. electron transport system and oxidative phosphorylation
 - 4. Krebs Cycle
 - B. Photosynthesis
 - 1. the light reactions
 - 2. the dark reactions
 - C. Protein synthesis
 - 1. DNA replication
 - 2. the genetic code
 - 3. M-RNA synthesis
 - 4. transcription
 - 5. translation
 - 6. enzymes
- VII. Cell Reproduction
 - A. Mitosis
 - B. Meiosis
- VIII. Mendelian Genetics
 - A. Law of Segregation
 - B. Law of Independent Assortment
 - C. Mendels factors are genes on DNA
- IX. Organismal Biology
 - A. Classification: The Whittacker System
 - B. Evolution
 - 1. Darwin-Wallace Theory
 - 2. Synthetic Theory
- X. The Origin of Life: Heterotroph Hypothesis

Vocabulary ListsQuiz One

Theory
Protoplasm
Matter
Nutrients
Biology

Hypothesis
Organism
Energy
Nutrition

Quiz Two

Respiration
Synthesis
Metabolism
Self-perpetuation
Steady State Controls
Reproduction
Adaptation
Elementary Particles
Atoms
Complexes of Compounds

Autotroph
Heterotroph
Photosynthetic Organism
Holotroph
Saprophyte
Parasite
Life
Growth
Compounds

Quiz Three

Organelle
Cell
Unicellular Organism
Multicellular Organism
Tissue
Organ
Organ System
Population
Biotic Community
Biome

Biosphere
Microscope
Electron Microscope
Light Microscope
Resolution
Stain
Ultra-structure
Membrane
Eukaryotic Cell
Prokaryotic Cell

Quiz Four

Nucleus
Nucleolus
*Cytoplasm
Mitochondrion
Lysosome
Endoplasmic Reticulum
Golgi Bodies
Vacuole
Ribosomes

Microfilaments
Microtubules
Cilia
Flagella
9 + 2 Construction
Centrioles
Plastids
*Leucoplasts
*Chromoplasts
Chloroplasts

*specific definitions required from Study Guide

Quiz Five

Plant Cell Wall
Bacterial Cell Wall
Middle Lamella
Plasmodesmata
Mesosome
Chromatophore
Nucleoid
*Osmosis
*Diffusion
*Turgor

*Permeable Membrane
Impermeable Membrane
*Selectively Permeable Membrane
*Isotonic Solution
*Hypertonic Solution
*Hypotonic Solution
*Plasmolysis
*Cytosis
*Active Transport

Quiz Six

Inert
Ion
Ionic Compound
Neutron
Proton

Solute
Solvent
Electron
Orbital

Quiz Seven

Chemical Bond
Covalent Bond
*Covalent Compound
Polar Bond
*Polar Compound
Single Bond
Double Bond
Triple Bond

Oxidation
Reduction
Hydrogen Bond
*Acid
*Base
Ionization
Weak Acid
Weak Base

Quiz Eight

Inorganic Compounds
Organic Compounds
Macromolecules
Polymer
Monomer
Dehydration Synthesis
Carbohydrate
Monosaccharide
Aldotriose
Aldotetrose
Aldopentose
Aldohexose
Aldoheptose
Ketotriose
Ketotetrose

Aldosugar
Ketosugar
Triose
Pentose
Hexose
Heptose
Disaccharide
Cellulose
Glycogen
Starch
Phosphorylated Sugar
Ketopentose
Ketoheptose
Ketoheptose

*specific definitions required from Study Guide

Quiz Nine (Also includes chemical structures)

<u>Structures</u>	<u>Vocabulary Words</u>
Glucose (Chain structure)	Phosphorylated sugar
Glucose (Ring Structure)	**Lipids
Glyceraldehyde	**Fats
Dihydroxyacetone	**Fatty Acids
Glucose-6-phosphate	**Saturated Fatty Acids
	**Unsaturated Fatty Acids
	**Phospholipids

Quiz Ten

Amino Acid	Nucleotide	Genetic Code
Enzyme	Peptide	
Substrate	RNA	
Anticodon	Protein Synthesis	
Nitrogen Base	Replication	
Codon	Ribosomal RNA	
DNA	Transcription	
Messenger RNA	Translation	
Transfer RNA	Triplet	

Quiz Eleven

Hemoglobin	General Structure of Amino Acid
Energy of Activation	Primary (I ^o) Protein Structure
Active Site	Secondary (II ^o) Protein Structure
Purine	Tertiary (III ^o) Protein Structure
Pyrimidine	Quaternary (IV ^o) Protein Structure
Adenine	Nucleotide
Guanine	Ribose Nucleotide
Cytosine	Deoxyribose Nucleotide
Thymine	Diagram of RNA
Uracil	Diagram of DNA
Coenzymes	Diagram of DNA Helix

Quiz Twelve

*ADP	*Citric Acid Cycle (Krebs Cycle)	FMA
*Aerobic	*Photon	FAD
*Anaerobic	*Photosynthesis	NAD
*ATP	*Light Reactions	NADP
*Chlorophyll	Exergonic Reaction	NADH + H ⁺
*Cytochromes	Endergonic Reaction	NADP + H ⁺
*Dark Reactions	Coupled Reaction	
*Electromagnetic Spectrum	Synthesis Reaction	
*Electron Transport Chain	Degradation Reaction	
*Fermentation	ATP Hydrolysis	
*Glycolysis	ADP Phosphorylation	

*specific definitions required from Study Guide

**specific definitions required from Textbook

APPENDIX B

ANSWER SHEET FORM A

BIOCONCEPTS

FALL 1980

Sample Vocabulary Quiz



NAME _____

DATE _____

QUIZ # _____

ANSWER SHEET FORM B

BIOCONCEPTS

FALL 1980



NAME _____

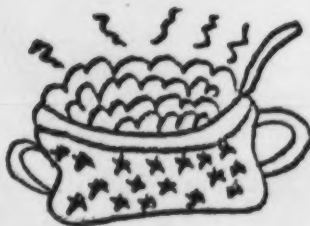
DATE _____

QUIZ # _____

BIOCONCEPTS
QUIZ #10 FORM A
Fall 1980

NAME _____

Sample Vocabulary Quiz



Stuffings

1. translation
2. triplet
3. genetic code
4. messenger RNA
5. protein synthesis
6. nucleotide
7. substrate
8. replication
9. ribosomal RNA
10. translation

BIOCONCEPTS
QUIZ #10 FORM A
Fall 1980

NAME _____



Turkeys

1. protein synthesis
2. transfer RNA
3. messenger RNA
4. peptide
5. enzyme
6. substrate
7. anticodon
8. amino acid
9. translation
10. replication

Bio Concepts - Assignment for the week of October 26, 1980

1. Read Chapter 5 Basic Chemistry in textbook.
 2. Study Guide Homework, p. 61-64 due Friday, October 31 (Halloween)
 3. Outline of Chapter 5, due Friday, October 31.
-

Bio Concepts - Homework Assignment, due Friday, November 14, 1980
(25 points)

Make-up 3 short answer questions on chemistry from your notes and answer your own questions.

Examples

Question I. Name three structures found only in plant cells.

Answer: 1. cell wall
2. chloroplast
3. central vacuole

Question II. What kinds of cells are photosynthetic?

Answer: 1. green plant cells
2. cyanobacterial cells
3. Eubacterial cells

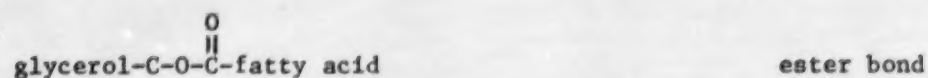
This is in preparation for Hour Exam #4 which will be on Wednesday, November 19, 1980. There will be 4 short answer questions on this hour exam. The exam will cover 1) compounds found in cells, 2) bonds, 3) reactions, 4) carbon bonding and structures, 5) carbohydrates, 6) lipids, 7) acids and bases, and 8) ph.

SEE ME BEFORE YOU REGISTER FOR PRINCIPLES!

For 100 point exam on Friday, November 7, 1980 (Exam III). For the functional groups - learn the abbreviations.

<u>Functional Group</u>	<u>Abbreviation</u>	<u>Name</u>
$\begin{array}{c} \text{O} \\ \\ -\text{C}-\text{O}-\text{H} \end{array}$	-COOH	carboxyl
-N-H-H	-NH ₂	amino
$\begin{array}{c} \text{H} \\ \\ -\text{C}=\text{O} \end{array}$	-CHO	aldehyde
$\begin{array}{c} \\ -\text{C}=\text{O} \end{array}$	-C=O	ketone
$\begin{array}{c} \\ -\text{C}-\text{SH} \end{array}$	-SH	sulfhydryl
$\begin{array}{c} \\ -\text{C}-\text{O}-\text{H} \end{array}$	-C-OH	alcohol
$\begin{array}{c} \\ -\text{C}-\text{OPO}_3\text{H}_2 \end{array}$	$\begin{array}{c} \\ -\text{C}-\text{P} \end{array}$	phosphate

Bonds



YES - there will also be a vocabulary quiz on November 7, 1980

The fourth hour exam, next Wednesday, November 19, 1980 will consist of:

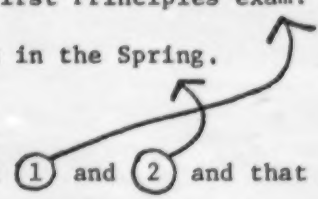
1. multiple choice
2. fill in the blanks, including structures on handouts, carbohydrates and lipids.
3. four short answer questions.

This exam will be very similar to a Principles exam and will contain questions I have taken from my old Principles exams. All questions will come from your notes.

The grade you obtain on this exam will help both you and me determine:

1. how well you might expect to do on the first Principles exam.
2. how many Biology courses you should take in the Spring.

Exam #4 is not the only criterion for determining (1) and (2) and that is why your appointment with me is necessary.



Thank you,

J. Mullins

1. Homework outline due Friday, December 12, 1980 - 1 point each day late.
(100 points)
2. 25 point, 15 min. vocabulary quiz on Friday. NO DROP. Spelling counts.
3. Homework (25 points) due Monday, December 15, 1980 - Answers to questions in Study Guide p. 87-89. 5 points each day late.
4. All incompletes must be made up on or by Wednesday, December 17.
5. Final Hour Exam (100 points) Friday, December 19, 1980.
This will be on your notes covering Proteins, Nucleic Acids, Protein Synthesis, Respiration and Photosynthesis.

NO MAKE-UPS

6. Grade will be based on:

5 (100) point lecture exams = 500 points

Homework = 300 points

8 (25) point quizzes = 200 points
(drop 4, except last 2)

1000 points

900 - 1000 = A

800 - 899 = B

700 - 799 = C

600 - 699 = D

less than 600 = F

Principles of Biology Survival Kit For Bio Concepts

December 19, 1980

1. Never miss a class - especially labs. These = 3 cuts and you will most likely never catch up.
2. Develop a buddy system - you and a friend should compare notes. Always rewrite your class notes. Get each others' phone number.
3. Bring a tape recorder to class if your instructor gives you permission to do so. If you don't have one, help buy tapes for a friend that does.
4. Memorize all your notes. Don't skip. Use up lots of ATP's when you study.
5. Study just as much for the lab quizzes as you do for the lecture exams.
6. Study Principles 2 to 3 hours each day.
7. Be sure you understand the labs. Read them before you go to lab class.
8. Buy the Principles text and lab manual and study over Christmas break.
9. Keep your study guide and use the questions as trial exams.
10. Make up your own questions from your notes.
11. Seek help as soon as you need it from your instructor or student tutors.
12. Never miss an exam.

OUTLINE OF SUBJECT MATTER COVERED IN PRINCIPLES

1. Microscopy
2. Eukaryotic Cell Structure
3. Prokaryotic Cell Structure
4. Physical Nature of Protoplasm
5. Carbohydrates
6. Lipids
7. Proteins-Enzymes
8. Nucleic Acids
9. Energetics
10. Photosynthesis
11. Respiration
12. Genetics
13. Protein Synthesis
14. Plant and Animal Reproduction and Development
15. Evolution
16. Ecology
17. Origin of Life

STUDY A LOT!

STUDY EVERY DAY!

Laboratory Exercises 2, 3, 4, 5, 7, 9, 6, 11, 10, 12, 13, 14, 16.

Good Luck!

J. Mullins

STUDY

STUDY

STUDY

STUDY

APPENDIX D

Questions for Hour Examination I (100 points, each individual question worth 5 points) were taken directly from the Study Guide (Applewhite and Wilson, 1978). Readers should refer to pages 4 to 7 of the Study Guide to see the types of questions asked on this examination.

Bio Concepts Hour Exam II

100 Points

(Each Question = 2 points)

I. Multiple Choice. There is only one correct answer to each question.
Place the letter of the correct answer in the blank.

- _____ 1. A cell with no defined nucleus or nuclear membrane is
 - a. prokaryotic
 - b. eukaryotic
 - c. cytolytic
 - d. all of the above

- _____ 2. Ribosomes are the site of
 - a. respiration
 - b. photosynthesis
 - c. absorption
 - d. protein synthesis

- _____ 3. Cytolysis is caused when a cell is exposed to a solution that is
 - a. hypertonic
 - b. isotonic
 - c. hypotonic
 - d. concentrated

- _____ 4. Eukaryotic cells have
 - a. a nucleus with no membrane
 - b. a nucleus with no DNA
 - c. DNA and no nucleus
 - d. a nucleus, nuclear membrane and DNA

- _____ 5. Microfilaments form a skeletal framework in the
 - a. centriole
 - b. cytoplasm
 - c. microtubules
 - d. endoplasmic reticulum

- _____ 6. The packaging center of the cell is the
 - a. ribosome
 - b. Golgi body
 - c. chloroplast
 - d. nucleus

- _____ 7. An example of a non-membrane bound organelle would be a
 - a. mitochondrion
 - b. lysosome
 - c. ribosome
 - d. vacuole

- _____ 8. A membrane is a structure made up of
 - a. lipids & amino acids
 - b. fats and amino acids
 - c. fats and sugars
 - d. a lipid protein bilayer

- _____ 9. All cells are bound by a
- a. cell wall
 - b. middle lamella
 - c. plasma membrane
 - d. primary wall
- _____ 10. Which of the following sets of organelles exist in both plant and animal eukaryotic cells?
- a. mitochondria, ER, centrioles
 - b. golgi bodies, cilia, chromosomes
 - c. nucleus, cytoplasm, ribosomes
 - d. leucoplast, cell wall, vacuole
- _____ 11. Which of the following prevents the cell from drying out and is known as the slime layer?
- a. plasma membrane
 - b. cell wall
 - c. capsule
 - d. cellulose
- _____ 12. A lysosome is a single membrane bound organelle which contains
- a. flagella and cilia
 - b. protein and RNA
 - c. digestive enzymes
 - d. all of the above
- _____ 13. Both prokaryotic and eukaryotic cells contain
- a. plasma membrane and nucleoid
 - b. murion cell wall and golgi bodies
 - c. plasma membrane and ribosomes
 - d. r-phycoerythrin and mesosomes
- _____ 14. The pressure that maintains firmness in plant cells is called
- a. cytolysis
 - b. skeleton
 - c. turgor
 - d. golgi
- _____ 15. Cilia and flagella are attached to eukaryotic cells by a
- a. lysosome
 - b. basal body
 - c. 9 + 2
 - d. 9 + 3
- _____ 16. A picture taken with an electron microscope is called
- a. an electrocardiogram
 - b. an electron micrograph
 - c. a microwave oven
 - d. an ultra structure
- _____ 17. The mitochondrion is the site of
- a. photosynthesis
 - b. oxygen requiring cellular respiration
 - c. protein synthesis
 - d. starch formation

- _____ 18. Which of the following are only found in prokaryotic cells?
- a. nucleus
 - b. nucleoid
 - c. nucleolus
 - d. all of the above
- _____ 19. Which of the following are found only in autotrophic cells?
- a. mesosomes and mitochondria
 - b. lysosomes and ER
 - c. chloroplasts and chromatophores
 - d. nuclei and nucleoids
- _____ 20. Which of the following are found in cytoplasm?
- a. ions
 - b. enzymes
 - c. organelles
 - d. all of the above

II. TRUE or FALSE. Place T or F in the blank provided. If the statement is false, correct the underlined.

- _____ 1. Impermeable membranes allow nothing to pass. _____.
- _____ 2. Bacteria are always photosynthetic. _____.
- _____ 3. Diffusion of water molecules across a selectively permeable membrane is called plasmolysis. _____.
- _____ 4. Centrioles are found only in eukaryotic animal cells. _____.
- _____ 5. Light microscopes use light to produce an image and magnify 2000 X _____.
- _____ 6. Active transport requires cell energy and moves against diffusion pressure. _____.
- _____ 7. Prokaryotic cells are all multicellular. _____.
- _____ 8. The cell theory states that all organisms are made up of cells. _____.
- _____ 9. In eukaryotic, multicellular organisms, the cells communicate with each other. _____.
- _____ 10. Cell energy is required for passive transport. _____.
- _____ 11. The bacterial cell wall is composed of cellulose. _____.
- _____ 12. Only plant cells have plastids. _____.
- _____ 13. Plant cells are eukaryotic. _____.

- _____ 14. Your cells are eukaryotic. _____.
- _____ 15. Oscar's cells are prokaryotic. _____.
- _____ 16. Resolution is the ability to distinguish between closely placed lines. _____.
- _____ 17. All prokaryotic cells are photosynthetic. _____.
- _____ 18. The cytoplasm consists of membrane enclosed spaces. _____.
- _____ 19. Rough ER has lysosomes attached to it. _____.
- _____ 20. The mesosome has the same function as the mitochondrion. _____.

III. Fill in the blanks. Each blank = 2 points.

1. Two examples of prokaryotic cells are _____ and _____.
2. The _____ secretes substances via vesicles that fuse to the plasma membrane.
3. Centricles are composed of a parallel triplets of _____.
4. Two structures found within chloroplasts are the _____ and _____.
5. Cells are the _____ and _____ units of life.
6. Halloween is on October _____.

Bioconcepts

Hour Examination III

Ten points for each structure or bond.

I. Draw the following functional groups.

1. Alcohol

2. Ketone

3. Amino

4. Sulfhydryl

5. Phosphate

6. Carboxyl

7. Aldehyde

II. Draw the following bonds.

1. Ester

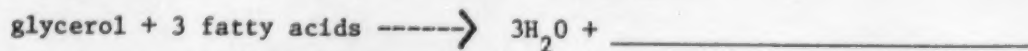
2. Peptide

3. Glycosidic

I. Multiple Choice. There is only one correct answer for each question. Two points each. Place the letter of the correct answer in the blank.

- _____ 1. A hexose is a(n)
a. substance that appears on Halloween
b. monosaccharide containing 6 carbon atoms
c. disaccharide containing 6 carbon atoms
d. polysaccharide
- _____ 2. A phosphorylated sugar is
a. non-reactive
b. non-existent
c. very reactive in cells
d. table sugar
- _____ 3. Which of the following are carbohydrates
a. deoxyribose
b. glucose-6 phosphate
c. glycogen
d. all of the above
- _____ 4. $\text{H}_3\text{C} - (\text{CH}_2)_n - \text{COOH}$ is the general formula for
a. formic acid
b. glucose
c. a saturated fatty acid
d. an unsaturated fatty acid
- _____ 5. Fatty acids
a. are completely ionized in water
b. are non polar
c. are really fats
d. have a polar part and a non-polar part
- _____ 6. Sucrose is a
a. fatty acid
b. monosaccharide
c. sugar alcohol
d. disaccharide

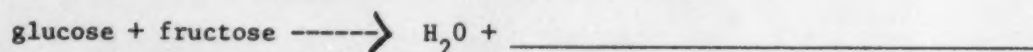
Questions 7, 8, and 9 refer to the following equation:



- _____ 7. The blank should read
a. wax
b. fat
c. steroid
d. sucrose
- _____ 8. The bond formed by the above reaction is a(n)
a. hydrogen
b. ester
c. glycosidic
d. none of the above

- _____ 9. The type of reaction is
- a. dehydration synthesis
 - b. hydrolysis
 - c. electrolysis
 - d. all of the above

Questions 10, 11 and 12 refer to the following equation:



- _____ 10. The above reaction is a type of
- a. ketone group
 - b. dehydration synthesis
 - c. monosaccharide
 - d. electronegativity
- _____ 11. The bond formed in this reaction is
- a. glycosidic
 - b. ester
 - c. peptide
 - d. hydrogen
- _____ 12. The blank should read
- a. starch
 - b. fat
 - c. steroid
 - d. sucrose

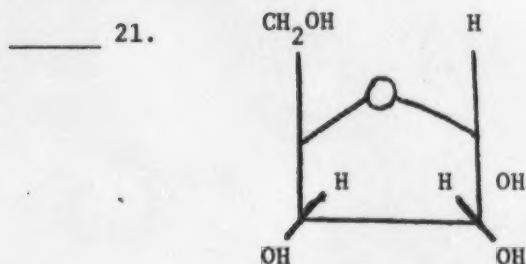
Questions 13, 14, 15, and 16 refer to this reaction:



- _____ 13. This type of reaction is
- a. electron transfer
 - b. electron sharing
 - c. non-polar
 - d. hydrogen bonding
- _____ 14. Na is
- a. oxidized
 - b. reduced
 - c. neutral
 - d. unchanged
- _____ 15. Na^+
- a. gains energy
 - b. loses energy
 - c. neither gains nor loses energy
 - d. both gains and loses energy
- _____ 16. Cl^- is a(n)
- a. atom
 - b. ion
 - c. polar molecule
 - d. non-polar molecule
- _____ 17. The most abundant inorganic compound in cells is
- a. salt
 - b. sucrose
 - c. water
 - d. vitamins

- _____ 18. Carbon can bond with
- carbon
 - hydrogen
 - oxygen
 - all of the above
- _____ 19. A molecule made up of a given group of atoms or small molecules which are repeated over and over again is a(n)
- monomer
 - polymer
 - boring molecule
 - water molecule

- _____ 20. Glucose is the monomeric unit of (or monomer of)
- starch
 - glycogen
 - cellulose
 - all of the above



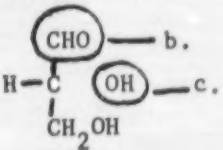
This molecule is a

- fat
 - disaccharide
 - pentose
 - nucleic acid
- _____ 22. Which of the following elements are not present in a fatty acid?
- carbon
 - nitrogen
 - oxygen
 - hydrogen
- _____ 23. Electron transfer reactions result in
- ionic bonds
 - covalent bonds
 - non-polar bonds
 - savings bonds
- _____ 24. One covalent bond is actually
- two electrons shared between atoms
 - two pairs of electrons shared between atoms
 - two electrons transferred from one atom to another
 - one electron shared between atoms
- _____ 25. Polar macromolecules
- can bond with parts of themselves
 - are very small molecules
 - do not exist in cells
 - exist only at the North Pole

- _____ 26. The symbol pH tells us about the
- number of H^+ in solution
 - the temperature of the solution
 - the hardness of the cell wall
 - none of the above
- _____ 27. A pH of 3 means a solution is
- acidic
 - basic
 - neutral
 - frozen
- _____ 28. Water
- is non-polar
 - breaks up ionic compounds into their component ions
 - is a poor solvent
 - all of the above

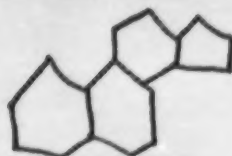
29 and 30 = 4 point gift.

II. Fill in the blanks. One point each blank.

- The most important polar bond in living things is the _____ bond.
- An _____ is a substance that gives off H^+ ions in solution.
- Fatty acids with two or more double bonds are called _____.
- A _____ acid or base is only partially ionized in water.
- An organic acid has the _____ functional group which ionizes in water.
- The pH of pure water is _____. This pH is said to be _____ (acidic, basic, neutral).
- Water molecules are bonded to each other by _____ bonds. These bonds are also found in living things and are _____ in strength.
- Electrons are _____ particles found _____ (inside, outside) atomic nuclei. Electrons are two kinds of energy: these are _____ and _____.
- Respiration is a series of _____ reactions.
- 

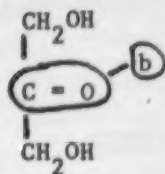
- name the molecule _____
- name the functional group _____
- name the functional group _____

11.



Name the type of molecule _____.

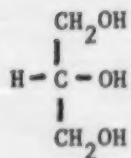
12.



a. name the molecule _____.

b. name the functional group _____.

13.



Name the molecule _____.

III. Short Answers 5 points each

1. Name three carbohydrates and give their function in cells.

2. What is the difference between a monosaccharide and a polysaccharide?

3. Name the four main types of organic compounds found in cells,

4. What is the difference between a polar bond and Von der Waals forces?

I. Multiple Choice. Place the letter of the correct answer in the blank. There is only one correct answer for each question. Each question is worth 2 points.

- _____ 1. Transcription of the genetic code to M-RNA occurs in the
a. Chromosome
b. Mitochondria
c. Ribosomes
d. Cytoplasm
- _____ 2. Transfer RNA
a. is a polymer of amino acids
b. carries an amino acid to the ribosome
c. has codons
d. all of the above
- _____ 3. Which of the following is not a molecular sub-unit of a nucleotide?
a. phosphate
b. pentose sugar
c. glycerol
d. nitrogen base
- _____ 4. The part of the nucleic acid molecule that carries stored information is the
a. sugar-phosphate backbone
b. helix
c. sequence of nitrogen bases
d. pentose sugar
- _____ 5. In the following reaction:
$$3 \text{ fatty acids} + \text{glycerol} \xrightarrow{\text{ATP} \rightarrow \text{ADP} + \text{P}} \text{fat} + \text{H}_2\text{O}$$

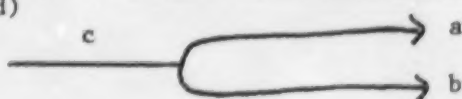
a. The hydrolysis of ATP provides the energy for the synthesis reaction.
b. The phosphorylation of ATP provides the energy for the degradation reaction.
c. No energy change is necessary.
d. ATP is an enzyme.
- _____ 6. The structure of DNA differs from the structure of RNA in that
a. DNA is double stranded
b. DNA is single stranded
c. RNA is double stranded
d. None of the above
- _____ 7. An amino acid is an acid because it has a _____ group.
a. amino
b. carboxyl
c. Ketone
d. alcohol

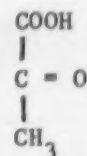
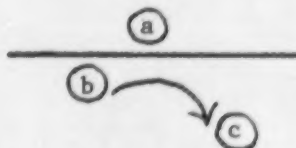
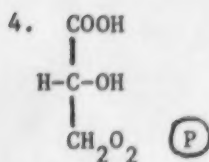
- _____ 8. Which bonds hold together the I^o structure of proteins?
a. hydrogen
b. peptide
c. ester
d. disulfide bridges
- _____ 9. Which bonds hold together the II^o structure of proteins?
a. hydrogen
b. peptide
c. VanderWaals forces
d. disulfide bridges
- _____ 10. Which bonds hold together the III^o structure of proteins?
a. hydrogen
b. VanderWaals forces
c. disulfide bridges
d. all of the above
- _____ 11. Enzymes
a. promote collisions
b. are catalysts
c. are proteins
d. all of the above
- _____ 12. Energy yielding reactions are
a. endergonic
b. exergonic
c. synthetic
d. impossible
- _____ 13. The function of the alcoholic fermentation of pyruvic acid is to
a. provide students with beer
b. regenerate NAD
c. regenerate NADH + H⁺
d. produce 38 ATP's
- _____ 14. In the priming reactions of glycolysis glucose is
a. synthesized
b. phosphorylated
c. hydrated
d. dehydrated
- _____ 15. Respiration is a series of _____ reactions.
a. endergonic
b. exergonic
c. synthetic
d. dehydration synthesis
- _____ 16. ATP
a. is found in all cells
b. couples endergonic and exergonic reactions
c. is a nucleotide triphosphate
d. all of the above
- _____ 17. The terminal electron acceptor in anaerobic respiration is
a. alcohol
b. oxygen
c. pyruvic acid
d. acetyl COA

- _____ 18. The terminal electron acceptor in aerobic respiration is
- lactic acid
 - oxygen
 - pyruvic acid
 - acetyl COA
- _____ 19. The function of the TCA (Krebs Cycle) is to
- completely oxidize glucose
 - produce ATP by substrate level phosphorylation
 - reduce NAD
 - all of the above
- _____ 20. In the mitochondrion
- NADH is oxidized to produce energy which is captured in the P bonds of ATP
 - cell wall synthesis occurs
 - fermentation reactions take place
 - ATP is hydrolyzed
- _____ 21. The light reactions of photosynthesis
- are enzymatic
 - occur in the grana
 - oxidize carbon
 - require NAD
- _____ 22. The function of the light reactions is to
- reduce carbon
 - oxidize carbon
 - produce $\text{NADPH} + \text{H}^+$ and ATP
 - synthesize ferredoxin
- _____ 23. The O_2 formed in photosynthesis comes from
- glucose
 - CO_2
 - H_2O
 - cytochromes
- _____ 24. ATP is produced in photosynthesis by
- the dark reactions
 - photosystem I
 - photosystem II
 - both photosystem I and photosystem II
- _____ 25. One function of the dark reactions in photosynthesis is to
- reduce carbon
 - oxidize chlorophyll
 - manufacture ribosomes
 - produce ATP
- _____ 26. One function of photosystem I is to
- reduce ferridoxin
 - produce O_2
 - send electrons to photosystem II
 - recycle O_2 molecules

- _____ 27. One function of photosystem II is to
- reduce water
 - add CO_2 to a sugar molecule
 - fill the e^- holes in photosystem I
 - reduce NAD
- _____ 28. The function of $\text{NADPH} + \text{H}^+$ produced in photosynthesis is to
- reduce carbon
 - oxidize carbon
 - form ATP in the mitochondrion
 - enter the Krebs's cycle
- _____ 29. ATP is produced in photosynthesis by
- oxidative phosphorylation
 - photophosphorylation
 - substrate level phosphorylation
 - hydrolysis
- _____ 30. Mullins thinks the most important enzyme on earth is
- alcohol dehydrogenase
 - carboxydismutase
 - splitting enzyme
 - hemoglobin

II. Fill in the blanks. One point each blank.

1. In the priming reaction of glycolysis ATP is _____
(phosphorylated, hydrolyzed)
2. fructose 1, 6 diphosphate 
- name the product _____
 - name the product _____
 - name the enzyme _____
3. In aerobic respiration, for every glucose molecule that enters the EMP pathway _____ molecules of pyruvic acid are formed and _____ molecules of ATP are formed by the end of the EMP pathway.

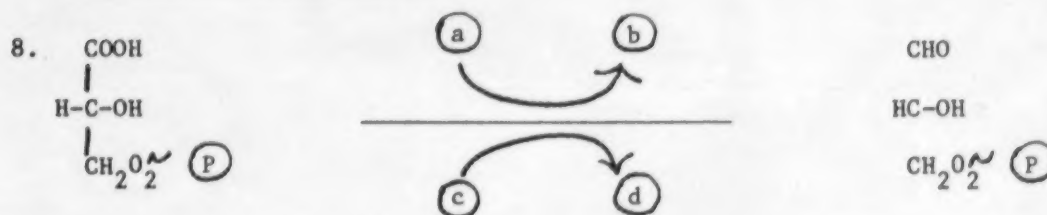


(d)

(e)

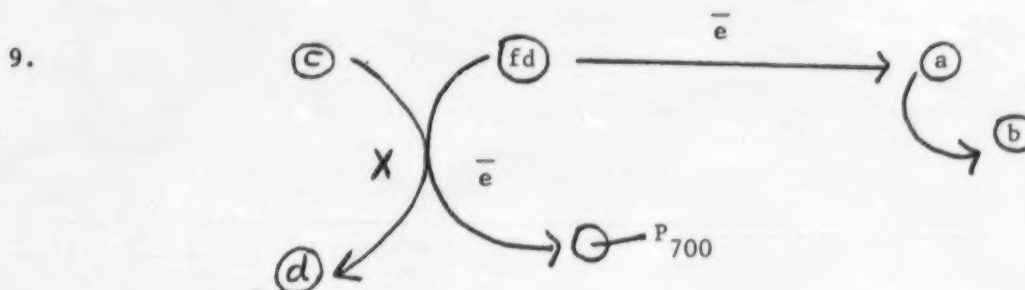
- name the type of reaction _____
- name the molecule _____
- name the molecule _____
- name the reactant _____
- name the product _____

5. Glucose enters the Krebs cycle as _____.
6. In the Krebs Cycle _____ molecules of ATP are formed. _____ of these come from $\text{NADH} + \text{H}^+$ and _____ are formed from $\text{FADH} + \text{H}^+$ by a process called _____ in the _____ (ribosome, mitochondrion).
7. In the Krebs Cycle, all the carbon from glucose is oxidized to _____.



Identify the molecules

- a. _____
- b. _____
- c. _____
- d. _____



Identify the molecules

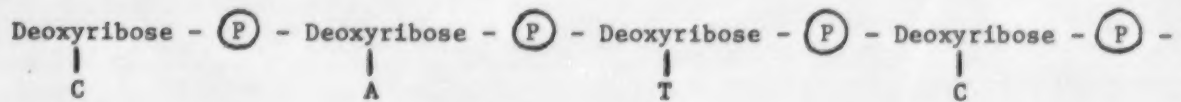
- a. _____
- b. _____
- c. _____
- d. _____

x. Name the specific type of reaction _____.

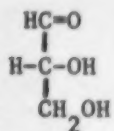
10. If the genetic code is CAT on the _____, then the codon _____ is _____ and the anti-codon on _____ is _____.
11. The genetic code carries information for the synthesis of _____ on the _____.
12. Ribose and deoxyribose are both _____.
13. In cells, there are _____ kinds of t-RNA.
14. Nucleotides are the monomeric units of _____.

III. Diagram (5 points)

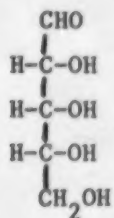
Fill in the rest of the structure of the DNA molecule:



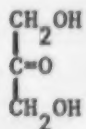
- 1.
- glyceraldehyde
- an aldotriose



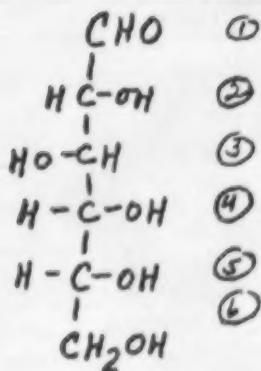
- 2.
- ribose
- an aldopentose



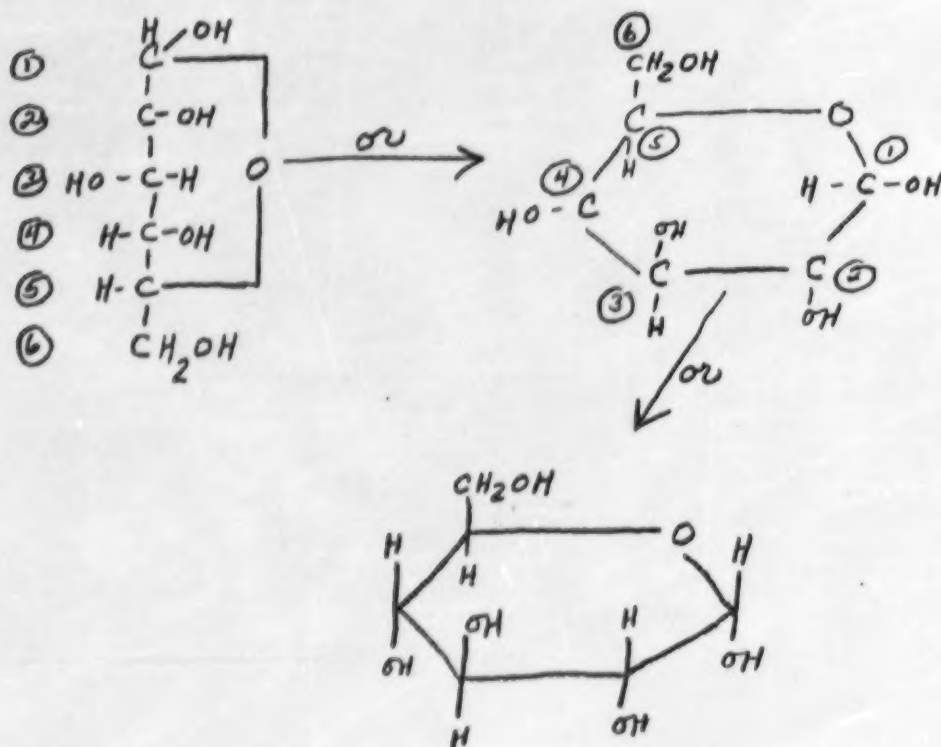
- 3.
- dihydroxyacetone
- a ketotriose



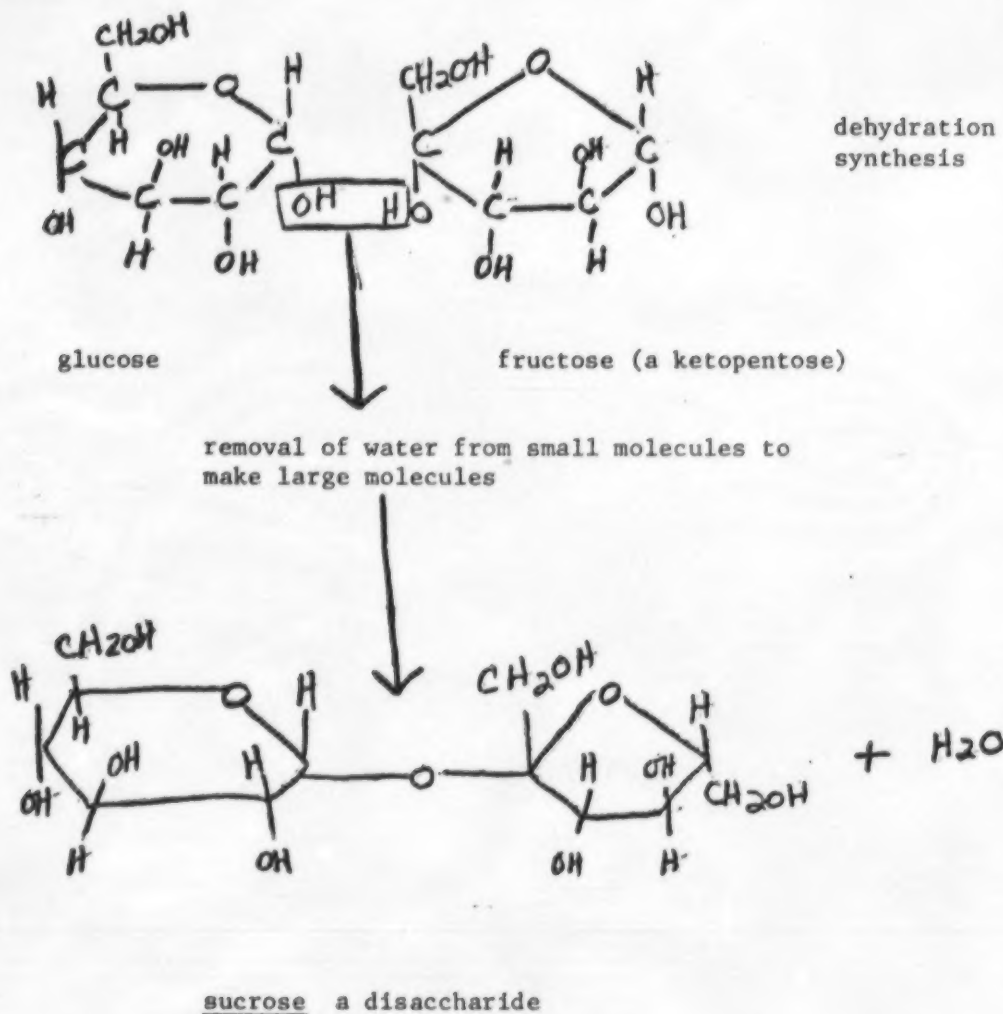
- 4.
- glucose
- an aldohexose



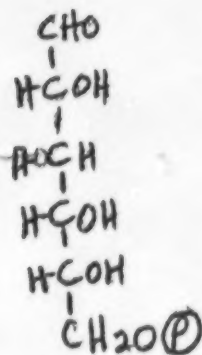
5. glucose ring structures



6. Formation of a disaccharide



7.

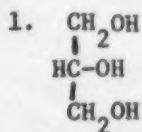
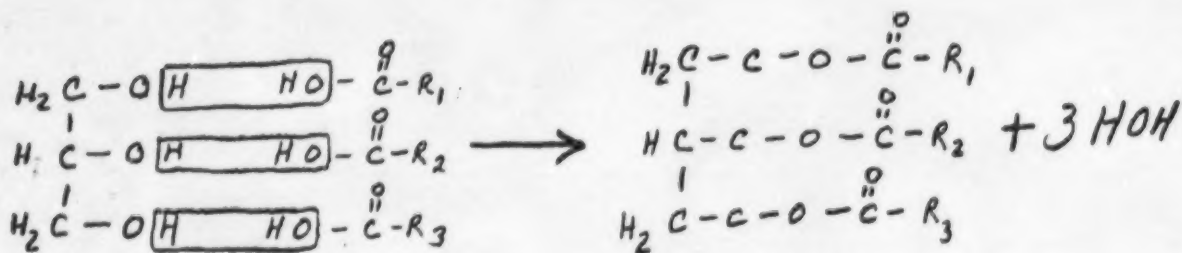


glucose 6 - phosphate
a phosphorylated sugar

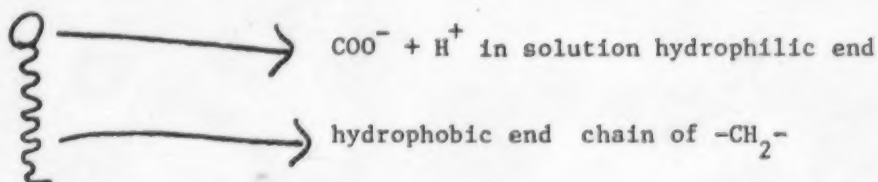
Lipids

I. Fatty Acids

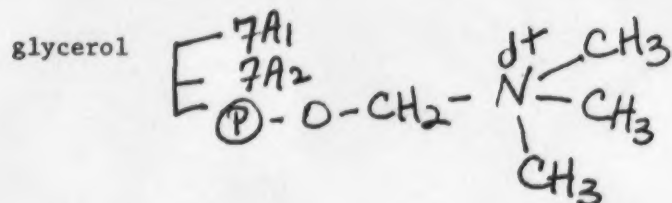
1. HCOOH formic acid
2. $\text{H}_3\text{C}-\text{COOH}$ acetic acid
3. $\text{H}_3\text{C}-(\text{CH}_2)_n-\text{COOH}$ general formula for fatty acids
4. $\text{CH}_3-(\text{CH}_2)_7-\text{C}^{\text{H}}=\text{C}^{\text{H}}-(\text{CH}_2)_7-\text{COOH}$ oleic acid - unsaturated

II. Glycerol (a sugar alcohol)III. Formation of a fat molecule (dehydration synthesis)

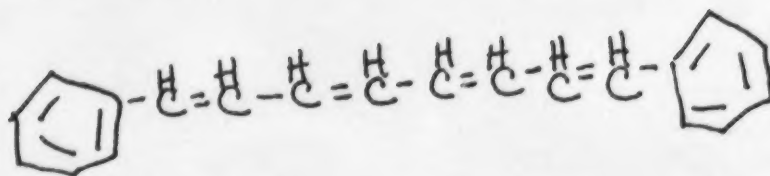
glycerol + 3 fatty acids $\longrightarrow$ one molecule of fat

IV. Diagram of a fat molecule

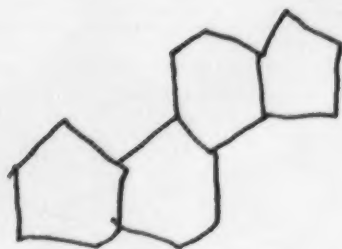
V. Phospholipid - lecithin



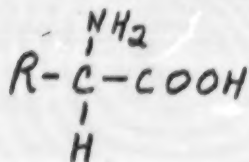
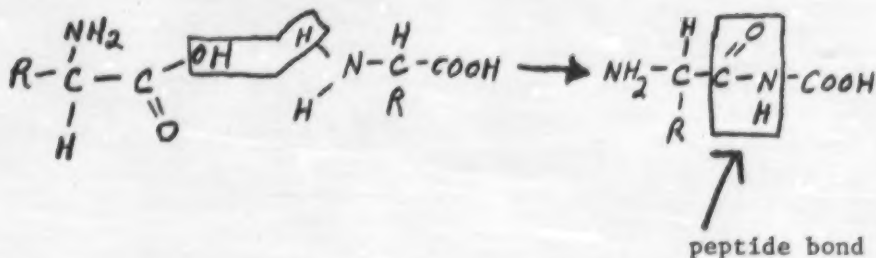
VI. Carotenoids



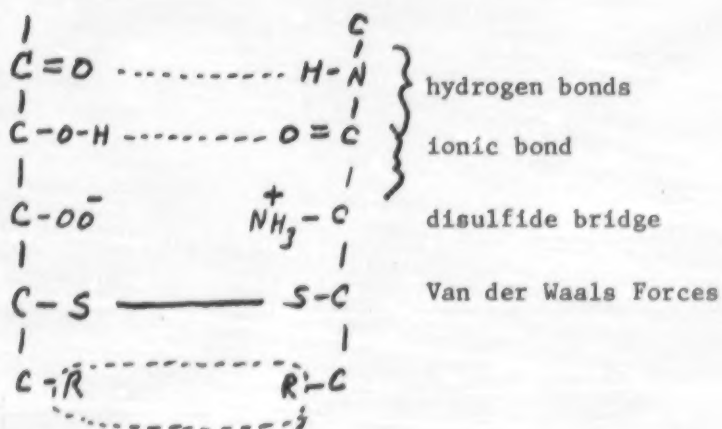
VII. Steroids

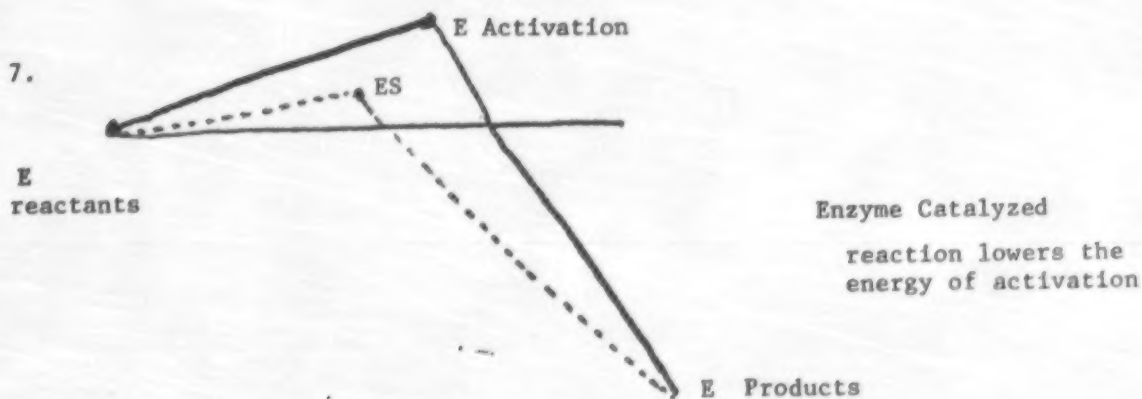
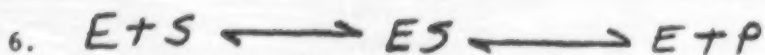
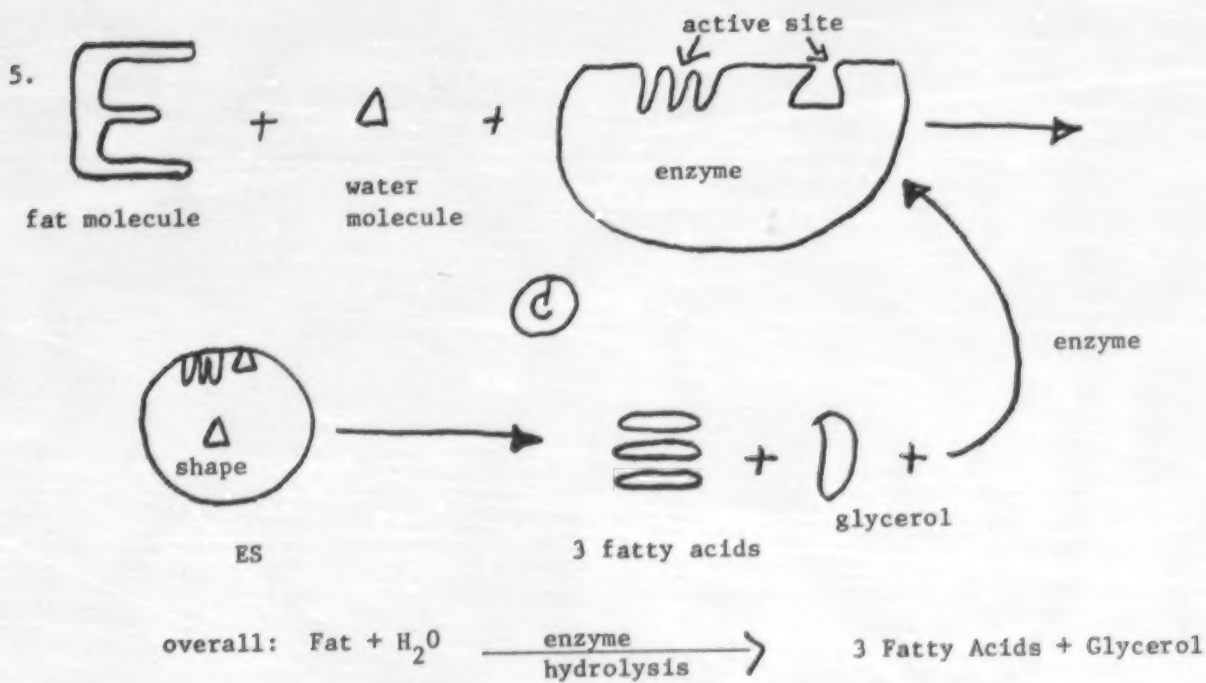


Proteins

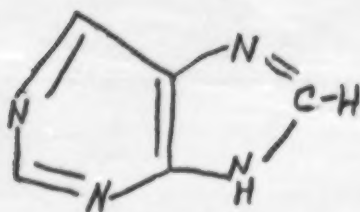
1. amino acid - general structure2. Formation of a dipeptide - dehydration synthesis

a dipeptide

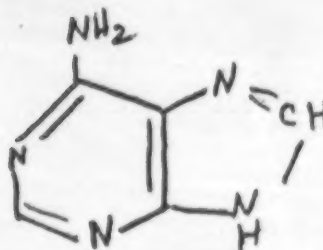
3. Bonds holding together III^o and IV^o protein structure



1. Purine Ring



Adenine: a purine



2. Pyrimidine Ring



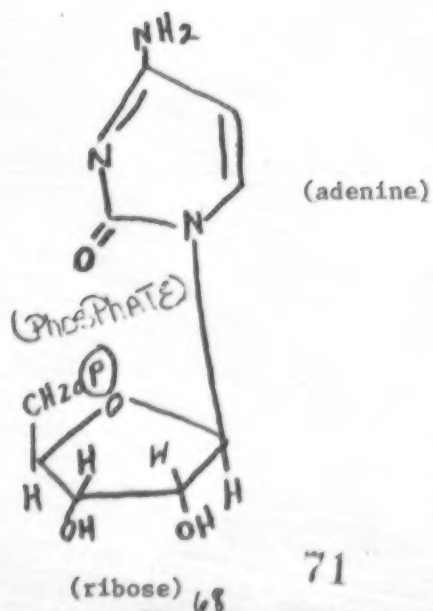
Cytosine: a pyrimidine



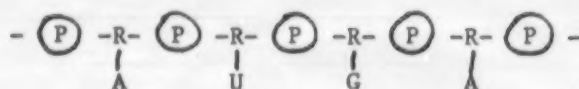
3. A nucleotide

adenosine monophosphate

AMP

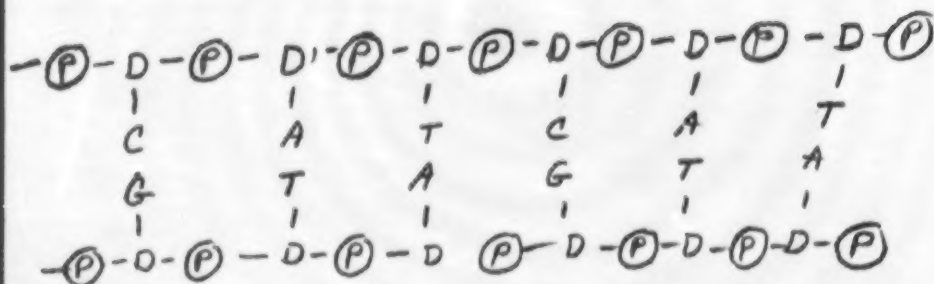


4. Diagram of RNA



R=Ribose
A=Adenine
U=Urasil
C=Cytosine
G=Guanine
Ⓟ = Phosphate

5. Diagram of DNA



D=Deoxyribose
A=Adenine
T=Thymine
C=Cytosine
G=Guanine
Ⓟ = Phosphate

6. Diagram of DNA helix

